ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;96:862-8

ORIGINAL RESEARCH

Immediate Effects of Repetitive Wrist Extension on Grip Strength in Patients With Distal Radial Fracture

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Abstract

Objective: To evaluate the immediate effect of repetitive wrist extension on grip strength in patients with distal radial fracture.

Design: Interventional study.

Setting: Patients who were admitted to a hospital department of occupational therapy.

Participants: Consecutive patients with a unilateral distal radial fracture (N=28).

Intervention: Each patient was randomly allocated to either the experimental group (n=14) or the control group (n=14). The experimental group performed 30 repetitive wrist extensions with maximal isometric contraction of the extensors of their affected hands during a 6-minute intervention period, whereas the control group did not perform the exercise.

Main Outcome Measures: Grip strength was measured just before and after the intervention period. Pain during grip strength measurements was also quantified using the visual analog scale. Wrist extension strength was measured 10 minutes after the grip strength measurement.

Results: Grip strength increased immediately after repetitive wrist extension in the experimental group, but it remained the same in the control group. Visual analog scale scores indicated that pain was relieved only in the experimental group. However, pain was unrelated to strength production.

Conclusions: The intervention used in this study might be useful during physical examination to reveal the potential grip strength of patients. The intervention may also be an effective warm-up training procedure in preparation for conventional grip-strengthening exercises.

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The decrease in grip strength after distal radial fracture (DRF) makes it difficult for patients to use their hands for many daily activities,[1,2] and recovery from this weakness is a major goal of rehabilitation. However, clinical treatment outcomes of patients with DRF have not necessarily been satisfactory.[3-6]

Numerous researchers have examined the relations between treatment outcome in terms of grip strength, the initial orthopedic treatment procedure, and radiographic examination findings,[3,7-12] but few studies have determined an effective occupational therapy (OT) treatment for the restoration of grip strength after DRF. Several authors reported that an early initiation of therapy after injury results in a rapid recovery of grip strength.[13-17] However, further studies are required to clarify what types of exercise are optimal for the quick recovery of or increase in grip strength after DRF.

The wrist should be stabilized by wrist extensors at a fixed position during the grasp,[18] at approximately 30° of wrist extension, to achieve a powerful grip.[19-22] Therefore, wrist extensors have to exert sufficient force to stabilize the wrist joint in the position.[23] Patients with DRF may not be able to exert enough grip strength that corresponds to wrist extension strength. We previously reported that the strength of wrist extensors highly correlated with grip strength in both the affected and unaffected sides of patients with DRF, and the decrease in grip strength on the affected side was greater than the value predicted from a regression equation for the unaffected side. In addition, stabilization of the wrist joint with a splint immediately improved grip strength on the affected side.[24] These results suggest that patients with DRF were not able to

Disclosures: none.

0003-9993/14/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2014.09.024

demonstrate their potential grip strength because of their inability to exert sufficient force to stabilize the wrist. Furthermore, treatment of acute DRF with a cast or surgical instruments commonly restricts wrist motion, and muscle disuse due to constriction may decrease muscle activation. Several studies[25,26] showed that muscle disuse reduced the muscle activation level.

Asano et al[27] reported that patients with DRF produced their maximum grip strength at later trials of 30 consecutive measurements for 6 minutes, whereas healthy subjects demonstrated their maximum grip strength in the first trial. These researchers suggested that the results in patients with DRF might be related to pain and/or the scar formation in the surrounding tissues of the fracture site. However, we hypothesized that the results might be related to the reduced activation of wrist extensors during the early trials, which might be improved through repetitive wrist extension exercises. This hypothesis is based on our clinical experiences and on the facts that grip strength tests involve an isometric contraction of wrist extensors and that muscle activation can be enhanced by voluntary contractions.[28] If these assumptions are correct, repetitive isometric contractions of these muscles could lead to an immediate increase in grip strength in patients with DRF. This procedure might be useful in the examination of the potential grip strength of patients, and it might also be effective in the treatment for the restoration of weakened grip strength. Therefore, the purpose of this study was to clarify the effects of repetitive isometric contraction on grip strength in patients with DRF.

Methods

Participants

Consecutive patients who were admitted between June and November 2011 to the Department of Rehabilitation Medicine at Fujisawa Shounandai Hospital for the treatment of DRF were included in the present study.

Participants attended the experiment after they had begun their passive range-of-motion exercises. The following exclusion criteria were used: (1) a history of a disease or other injuries that weaken the upper extremities; (2) a complication of complex regional pain syndrome, carpal tunnel syndrome, or tendon rupture after injury; (3) difficulty in understanding instructions because of cognitive disorders such as dementia; (4) inability to move the affected wrist to more than 0° of flexion and/or 30° of extension; and (5) bilateral injury.

The Research Ethics Committee of the School of Nursing and Rehabilitation Sciences at Showa University (approval no. 149) and the Bioethics Committee of Fujisawa Shounandai Hospital approved the present study.

Forty-four patients with DRF were selected for the study, 1 of whom met an exclusion criterion and was excluded. Twenty-eight of the remaining 43 patients agreed to participate in the study. Written informed consent was obtained from all the participants. The mean age of the participants was 63±13.0 years (range, 27−81y). Fractures were reduced at a mean of 5.8±6.8 days (range, 0−22 d) after injury, and OT was initiated at a mean of 31.5±12.4 days (13−54d) after injury. The mean treatment period was 69.6±74.7 days (range, 3−301d). In the initial orthopedic treatments, 11 patients were treated conservatively with casts and 17 patients underwent surgery for the fixation of the fracture. In the patients treated with casts, fractures were reduced at a mean of 0.2±0.4 days (range, 0−1d) after injury and OT was started at a mean of 44.8±4.9 days (36−54d) after injury. In the patients treated with surgery, fractures were reduced at a mean of 9.5±6.4 days (0−22d) after injury and OT was started at a mean of 22.7±6.3 days (13−35d) after injury.

List of abbreviations:

DRF distal radial fracture
OT occupational therapy
VAS visual analog scale

The definitions of radiographic examination results (mean ± SD; range) were as follows: mean dorsal angulation (−2.6°±14.1°; −43° to 12°), the angle measured on the lateral radiograph between a line perpendicular to the long axis of the radius and the articular surface indicated by a line joining the volar and dorsal margins of that surface[29]; mean radial inclination (21.0°±5.0°; 11°−28°), the angle measured on the frontal radiograph between a line perpendicular to the long axis of the radius and the radial articular surface indicated by a line joining its radial and ulnar margins[29]; and mean radial shortening (0.8±2.9mm; −5 to 6mm), measured on the frontal radiograph as the vertical distance between the distal end of the ulna and medial corners of the radius.[30]

Study protocol

Figure 1 shows the experimental procedures. Every 2 consecutive patients were randomly allocated to either the experimental group or the control group. Data collection was performed at the Department of Rehabilitation Medicine, Fujisawa Shounandai Hospital, Kanagawa, Japan.

At first, measurements of grip strength and the visual analog scale (VAS) of pain were performed for each of the participants (pretest). Just after these measurements, participants in the experimental group underwent repetitive wrist extensions only with their affected side during a 6-minute intervention period, whereas control group participants were allowed a 6-minute rest. Just after the intervention period, the grip strength and pain were measured as described in the pretest.

The wrist extension strength of both hands was measured in all the participants 10 minutes after the grip strength measurement. All the measurements were conducted in each patient before their routine exercise.

Repetitive wrist extension

Participants held a lightweight rod (approximately 5g; diameter, 1cm; length, 20cm) gently with their affected hand to keep their finger joints flexed during repetitions of wrist extension. Participants moved their wrists quickly up to the position of full extension and maintained isometric contractions for 3 seconds with maximum effort. Subsequently, they rested for 3 seconds, keeping the wrist relaxed. This combination of contraction and relaxation was repeated 10 times for 1 minute, followed by a 1-minute rest period. This sequence was repeated 3 times. Therefore, 30 repetitions of wrist extensions were performed for 6 minutes. This protocol was decided with reference to Asano et al.[27] Participants were encouraged by the occupational therapist to give their maximum effort during each trial.

Grip strength measurement

Grip strength was measured with a Jamar Digital Hand Dynamometer.[a] The grip handle was adjusted to the position of the